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Work schedule and physical factors in relation to fecundity in nurses

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Abstract

Objectives—To evaluate the association of work schedule and physical factors with fecundity.

Methods—Women currently employed outside the home and trying to get pregnant (n=1739) in the Nurses' Health Study 3 cohort (2010–2014) were included in this analysis. Work schedule and physical labour were self-reported on the baseline questionnaire, and every 6 months thereafter the women reported the duration of their ongoing pregnancy attempt. Multivariable accelerated failure time models were used to estimate time ratios (TR) and 95% CIs.

Results—Among the 1739 women (median age=33 years, 93% Caucasian) the estimated proportions of women not pregnant after 12 and 24 months were 16% and 5%, respectively. None of the various shift work patterns were associated with duration of pregnancy attempt (as a

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surrogate for fecundity). However, women working >40 h/week had a 20% (95% CI 7 to 35%) longer median duration of pregnancy attempt compared to women working 21–40 h/week (p-trend=0.005). Women whose work entailed heavy lifting or moving (ie, 25+ pounds) >15 times/day also had a longer median duration of pregnancy attempt (adjusted TR=1.49; 95% CI 1.20 to 1.85) compared to women who never lifted or moved heavy loads (p-trend=0.002). The association between heavy moving and lifting and duration of pregnancy attempt was more pronounced among overweight or obese women (body mass index, BMI<25: TR=1.17; 95% CI 0.88 to 1.56; BMI≥25: TR=2.03, 95% CI 1.48 to 2.79; p-interaction=0.007).

Conclusions—Working greater than 40 h per week and greater frequency of lifting or moving a heavy load were associated with reduced fecundity in a cohort of nurses planning pregnancy.

INTRODUCTION

The nursing profession is one of the fastest growing workforces in healthcare, with women of reproductive age constituting about 70–80% of this group.[12] Several papers have reviewed the occupational exposures of healthcare workers and all propose that reproductive health issues are a concern.[3–5] While much of this literature is focused on chemical hazards, the work schedule and physically demanding aspects of nursing are also potential threats to reproductive health. Shift work, long working hours, lifting heavy loads and prolonged standing each affect up to a third of nurses.[6–9] In other studies, these exposures have been associated with disrupted circadian regulation,[10] altered hormonal balance,[11] mental and physical fatigue[12] and sleep deprivation.[13]

Previous studies have linked shift work, long working hours and physical factors to an increased risk of menstrual cycle disturbances,[1415] spontaneous abortion,[16] preterm birth,[17] and low birth weight;[17] however, the association with fecundity is inconsistent: three studies found an association between shift work and subfecundity[18–21] while three others found no effect.[22–24] Moreover, a recent meta-analysis found a non-significant effect of shift work compared with no shift work on infertility (adjusted OR: 1.12; 95% CI 0.86 to 1.43).[25] Long working hours were associated with reduced fecundity in two studies[1824] but not in two others.[2123] The only previous study that has evaluated physical factors at work and fertility found that work with high intensity and fatigue was associated with reduced fecundity in non-medical female hospital workers.[26]

The aim of this analysis was to determine the extent to which work schedules and physical factors are associated with fecundity in a cohort of female nurses.

METHODS

Study population

The Nurses' Health Study 3 (NHS3) is an on-going internet-based cohort study of female nurses in the USA and Canada. To be eligible for the study women had to be either a registered nurse, licensed practical/vocational nurse or nursing student and born on or after 1 January 1965. As of September 2014, 38 016 women had joined the study and 26 693 women had completed at least one follow-up questionnaire, forming the base population for our analysis. Every 6 months questionnaires are sent to participants to update lifestyle and medical characteristics. The response rate for the second questionnaire is currently at 72%; for women who have completed at least two questionnaires, subsequent response rates exceed 80%. Women were eligible for this current analysis if they reported working as a nurse on their baseline questionnaire and reported on any of the subsequent questionnaires that they were trying to get pregnant (n=1757). We excluded women who reported that they were postmenopausal (n=15) or were missing information on duration of ongoing pregnancy attempt (n=3). After these exclusions, 1739 women were available for analysis. An overview of the study design is shown in online supplementary figure S1. The study was approved by the Institutional Review Boards of the Brigham and Women's Hospital (Boston, Massachusetts) and the National Institute for Occupational Safety and Health (Cincinnati, Ohio). Completion of the web-based questionnaires implied informed consent.

Exposure assessment

Besides demographics, lifestyle and medical characteristics, the baseline questionnaire also collects information about work schedule, physical aspects of work and select occupational exposures. Women report the average hours worked per week in the past year using the following categories: none, 1–20, 21–40, 41–60 and >60. Women are also asked to classify their usual work schedule over the previous year as either: days only, evenings only, nights only, rotating with nights and rotating without nights. In our questionnaire, a 'night shift' is defined as one in which most hours worked fell between midnight and 8:00. To assess frequency of night work, data are collected on how many night shifts are worked per month: none, 1–2 nights per month, 3–4 nights per month, 2–3 nights per week and >3 nights per week. Women also report the number of years they worked rotating night shifts (defined as at least three nights per month in addition to days or evenings in the same month) and total number of years they worked night shifts without rotation. We combined these two questions to create a variable of total duration of night shift work. To collect information on physical labour at work, we ask how many hours per day, on average over the past month, each participant was on her feet at work (standing or walking): <1, 1–4, 5–8, or >8 h per day. We also ask how many times per day, on average over the past month, she lifted or moved a physical load of 25 pounds or more at work (including repositioning or transferring patients): none, 1–5 times/day, 6–15 times per day, or >15 times per day.

Outcome assessment

Women who report that they are actively trying to get pregnant are asked to report the current duration of their ongoing pregnancy attempt. Specifically, they are asked: "For how many months have you been actively trying to get pregnant?" Categories for response include: ≤1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12 months, 1–2 years and 3+ years. We took a woman's first report of ongoing pregnancy attempt after the baseline questionnaire as her outcome. As such, the majority of current durations were reported on questionnaire 2 (65%) followed by questionnaire 3 (21%) and questionnaire 4 (14%). Validity of self-report of duration of pregnancy attempt has not been assessed in this population; however, the prospective report of a woman's on-going duration of pregnancy attempt is considered the gold-standard methodology for assessment of fecundity among pregnancy planners.[27][28]

Covariate assessment

Information on potential confounding variables is assessed on the baseline questionnaire including age, race/ethnicity, height, weight, lifetime pregnancy history, smoking history and marital status. Body mass index (BMI) was calculated as weight in kilograms divided by height in metres squared. In a previous validation study, self-reported weight was highly correlated with weight measured by a technician among a similar group of nurses (r=0.97).[29] Menstrual cycle characteristics including current regularity and length of a usual menstrual cycle are reported on the first follow-up questionnaire. Participants provided the current regularity of their menstrual cycles in the following categories: 'very regular (±3 days), regular, usually irregular or always irregular.' For analysis, we compared 'regular' (very regular or regular) to 'irregular' (usually or always irregular). Menstrual cycle length was reported in the following categories: 21, 21–25, 26–31, 32–39 and 40–50 days and >50 days or too irregular to estimate. For analysis, we defined a normal length menstrual cycle as lasting 21–39 days and all other categories were considered abnormal length. We also categorised menstrual cycle length into short (≤25 days), normal (26–31 days), long (32–50 days) and >50 days. Other occupation exposures such as current exposure to radiation, antineoplastic drugs, high-level disinfectants and anaesthesia gas were assessed on the baseline questionnaire by asking women to report whether they worked with these types of exposures (yes, no, or don't know). If women reported 'yes' they were considered as currently exposed. All other responses were classified as unexposed. On the third follow-up questionnaire, women are asked what their average total numbers of hours of sleep are over a 24 h period. Options for response are: <5, 5, 6, 7, 8, 9 and 10+.

Statistical analysis

Initial descriptive analyses included the inspection of missing data and extreme values, distributions of occupational factors and current duration of pregnancy attempt data, and assessment of potential confounders. To analyse our data, we used a current duration approach which uses information collected in a cross-sectional fashion on current duration of ongoing pregnancy attempt to make inferences about actually realised waiting times to pregnancy.[30] Other studies have utilised this approach to estimate the national prevalence of infertility[31,32] and the association of environmental factors on fecundity.[33] Since couples who have long durations of attempting pregnancy are overrepresented in the current duration approach, appropriate statistical models are used to account for this length-biased sampling. The current duration approach and more generally backward recurrence time survival methods allow us to infer the relationship of characteristics to the (unobserved) total duration of pregnancy attempt by using the (observed) current duration of attempt via accelerated failure time models.[30] Based on previous research we chose an accelerated failure time model with log normal distribution to estimate the time ratios (TRs) and 95% CIs.[33] Other outcome distributions such as generalised γ were also explored. The TRs correspond to exp([β]) and can be interpreted as the ratios of the median values of the duration of pregnancy attempts between the compared groups. Tests for linear trend across categories were conducted by using the median values in each category as a continuous variable. In addition to unadjusted models, multivariable models were adjusted for a priori selected demographic variables. These included current age, BMI, smoking status, marital status and race. Multivariate models were further adjusted for other work-related factors, as many of our exposures were correlated. We ran models with and without adjusting for pregnancy history as adjusting for reproductive history might lead to overadjustment if ongoing work schedule characteristics are related to the inability to get pregnant which could manifest as nulligravidy.[34,35] Missing covariate data were rare—two women were missing data on smoking status and this was the only variable with missing data. To accommodate these missing responses, a categorical indicator was used.

Sensitivity analyses were performed to evaluate effect modification by age (≤37 years, >37 years), BMI (<25 kg/m^2, ≥25 kg/m^2) and gravidity (nulligravid, gravid). We also investigated whether any observed associations with shift work or physical labour were mediated through or modified by current menstrual cycle characteristics or typical sleep hours. Finally, we investigated whether there were any interaction between highly fatiguing work and physical labour, as suggested by other studies.[26] SAS statistical software (V.9.3) was used for all analyses. A significance level of α=0.05 was used for all analyses.

RESULTS

Overall, 1739 women contributed information to this analysis. The women in this cohort had a median age of 33 years, 44.1% were overweight or obese, 22.4% were ever smokers, 75.7% were married, 92.8% were White and 59.5% were nulligravid (table 1). The majority of women worked days or evening only (63%), 17% of women worked night only shifts, 16% worked rotating shifts with nights and 4% worked rotating shifts with no nights. Thirty-two percent of women reported night work in the past month, 47.5% had a history of working rotating night shifts and 56.4% had a history of working permanent night shifts. The mode of time spent standing or walking at work was >8 h/day (34.4%) and the mode of frequency of moving or lifting a heavy load (25+ lbs) at work was 1–5 times/day (40.2%) in our cohort. The estimated survival function of current duration of pregnancy attempt using a log-normal distribution is shown in figure 1. The estimated proportions of women not pregnant after 12 and 24 months were 16% and 5%, respectively.

Typical work schedules over the past year were not significantly associated with fecundity in adjusted analyses (table 2). Longer hours of nursing work over the past year, however, was significantly associated with reduced fecundity. The adjusted effect of a woman working >40 h/week corresponded to a 20% (95% CI 7% to 35%) increase in the median duration of pregnancy attempt compared to women working 21–40 h/week (p-trend=0.006). Further adjustment for current menstrual cycle characteristics (regularity or cycle length) or typical sleep hours had little effect on this result. Stratification by or adjustment for gravidity also produced similar results (data not shown). Frequency of night work in the past month and duration of rotating or non-rotating night shifts were not significantly associated with fecundity in the adjusted models.

Increased frequency of lifting or moving a heavy load at work (including repositioning or transferring patients) in the past month was associated with reduced fecundity (table 3). After adjustment for demographic and work-related confounders, women lifting or moving a heavy load >15 times/day had a 49% (95% CI 20% to 85%) longer median duration of pregnancy attempt compared to women who never lift heavy loads (p-trend=0.002). After further adjustment for current menstrual cycle regularity, this association was attenuated (TR: 1.43 95% CI 1.10 to 1.83). When the analysis was restricted to women with always or usually regular menstrual cycles (n=973), this association was further attenuated (TR: 1.33 95% CI 0.98 to 1.80). Greater time spent standing or walking at work was not significantly associated with fecundity in this cohort.

The inverse association between work hours and fecundity was consistent across a variety of different strata of age, BMI, parity and night work; however the relationship between frequency of lifting or moving a heavy load and fecundity was significantly modified by BMI (p-interaction=0.007). While there was a consistent inverse association between frequency of moving or lifting a heavy load and fecundity in normal weight (BMI <25 kg/m^2) and overweight and obese women (BMI ≥25 kg/m^2), the association was more pronounced in overweight and obese women (BMI ≥ 25 kg/m^2). Specifically, overweight or obese women reporting lifting or moving heavy loads >15 times/day had a twofold longer median duration of pregnancy attempt (TR: 2.03 95% CI 1.48 to 2.79) compared to overweight or obese women reporting no moving or lifting of heavy loads (p-trend=<0.001). Of note, normal weight (BMI <25 kg/m^2) and overweight and obese women (BMI ≥25 kg/m^2) were equally likely to report lifting or moving a heavy load >15 times per day at work (6% vs 7%, respectively). Parity and age did not significantly modify the associations between frequency of work and lifting or moving a heavy load and fecundity.

DISCUSSION

In this ongoing cohort of female nurses, working >40 h per week and lifting or moving a heavy load >15 times per day (including repositioning or transferring patients) were associated with reduced fecundity (longer median duration of pregnancy attempt). The association between moving or lifting heavy loads and fecundity appeared to be partially mediated through menstrual cycle disturbances. Type of work schedule, frequency of night work, duration of rotating and non-rotating night shifts and time spent walking or standing at work were not associated with current duration of pregnancy attempt.

Of the multiple characteristics of work schedule that we evaluated in this study, only the number of hours worked per week was related to fecundity. The lack of association between shift work and fecundity, after adjusting for other demographic and work characteristics, is consistent with a recent meta-analysis that found no significant association between shift work (work outside 8:00 to 6:00) and infertility (time to pregnancy exceeding 12 months; adjusted OR, 1.12, 95% CI 0.86 to 1.43).[25] The literature on working hours and fecundity is inconsistent; long working hours were associated with reduced fecundity in two studies[1824] but not in two other studies.[2123] There are, however, possible biological explanations for this observation, including dysregulation of circadian rhythm through increased sleep deprivation 36 and stress 37 or decreased sexual intercourse.[24] While we were able to control for total sleep duration over a typical 24 h period, and it seemed to have little impact on the association between work hours and fecundity, this variable might not capture sleep deprivation. We were unable to determine the mechanism through which long work hours were delaying pregnancy. Clearly, further study of the relation between working hours and fecundity is warranted.

Several previous studies have shown that heavy work, both in terms of physical strain and long hours may have an adverse effect on pregnancy maintenance[16] and certain pregnancy outcomes,[17] yet its association with fertility has been studied less. In general, physical workload is an ill-defined concept and studies apply different measures ranging from basic self-reports to elaborate measures based on calculated energy expenditure. In agreement with our findings, the one study that has evaluated physical work (estimated based on total energy expenditure of work activities) and fertility found that non-medical female hospital workers who worked jobs with high intensity (high energy expenditure per working day) and fatigue (high energy expenditure per working hour) had reduced fecundity.[26] This study was unable to assess effect modification by body weight, as it was not measured. While our finding on heaving moving and lifting and fecundity appeared to be partially mediated by disturbances in menstrual cycle function, which is consistent with previous work from this cohort,[15] future studies are needed to further explore this relationship and possible mediating pathways.

An unexpected finding was that the adverse effect of heavy moving and lifting on fecundity was much stronger in overweight and obese women. One plausible explanation is that overweight and obese women with high physical demands on the job are less likely to engage in other health promoting behaviours in leisure time (eg, physical activity, healthy diet).[38] There could also be residual confounding by body weight, which might have been poorly captured by self-report in the overweight and obese women. Thus, other extraneous variables (and not actually heavy lifting) could be driving this adverse relationship between heavy lifting and fecundity in overweight and obese women. Another more speculative explanation for the observed effect is that job strain-related elevations in cortisol levels carry a bigger pathophysiological burden among obese than non-obese individuals.[39]

Since our study consisted entirely of working women who were planning a pregnancy there are two important potential biases worth considering. First, if any of our working conditions are associated with unplanned pregnancies and if these unplanned pregnancies also have longer or shorter waiting times to pregnancy this could have resulted in biased findings.[40] To address this possibility, we looked at pregnancy planning among women enrolled in our Maternal Health Study, a substudy of pregnant participants within the NHS3 cohort. Women with planned (76%) and unplanned (24%) pregnancies reported similar work exposures, indicating that any planning bias is likely minimal for these exposures. Second, it has been shown that women who have not had a successful pregnancy are more likely to remain in the workforce and may have more opportunity for occupational exposure than women who work part time so they can stay at home with young children.[41] This is termed the ‘infertile worker effect’.[42] However, considering our results remained significant after adjustment for many of the socioeconomic variables associated with employment status in our cohort and there was no significant difference in effect in analyses restricted to nulliparous women, it seems unlikely that the infertile worker effect is strongly biasing our findings.

Our study had other limitations worth noting. While we tried to control for many factors related to employment status, the amount and type of work a woman chooses to take on reflects numerous aspects of her life, many of which are hard to quantify, such as socioeconomic status and financial pressure. Since this was a secondary analysis of existing data, we also lacked information on possibly important confounders such as frequency of sexual intercourse or characteristics of the male partner. Thus, there may still be residual confounding by many of these factors that were poorly measured or not measured. For instance, if women working long hours had lower frequency of sexual intercourse this could explain our results for the lower fecundity observed in this group. However, it is currently unknown to what extent differences in patterns of intercourse may exist among groups defined by various work exposures and to what extent these patterns might be correlated with (and therefore partially adjusted for) our measured demographic factors. Similarly, men with jobs that require heavy exertion have been shown to have reduced semen quality.[43] If a couple's physical work strain is correlated (the extent to which is also unknown) then this unmeasured variable could be one explanation for our results with heavy lifting and reduced fecundity. We also only used one exposure assessment and thus we assumed that this exposure was constant for the duration of the woman's pregnancy attempt.[33] If there were changes in behaviour in response to having experienced longer pregnancy attempts, this could have resulted in exposure misclassification. Fortunately, exposure was assessed at least 6 months prior to pregnancy duration assessment, thus it is unlikely that this exposure misclassification was differential with respect to duration of pregnancy attempt. We also did not have information on current use of infertility treatment. If use of infertility treatment shortens or lengths a woman's duration of pregnancy attempt, then our results could be biased in either direction. Of note, we tried to minimise the effect of this by assigning all women with a current duration of pregnancy attempt >3–3 years and in sensitivity analyses we changed this cut-off to 1 and 2 years. In all analyses, results remained similar. Finally, we were limited in our assessment of physical workload as we only used two questions with unclear validity in this cohort of nurses. Future work which better aims to characterise physical workload in terms of intensity, fatigue and strain are clearly needed.

Our study had several strengths. First and foremost, by using a current duration approach, as compared to more traditional time to pregnancy approaches, we were able to include both women with high fertility (who are excluded from many prospective cohorts) and those who are involuntarily infertile (who are excluded from retrospective pregnancy cohorts). Second, prospective report of a woman's on-going duration of pregnancy attempt is considered the gold-standard methodology for assessment of fecundity among pregnancy planners. Finally, due to the homogenous nature of this cohort (eg, all nurses with some level of health-related education), many socioeconomic factors were inadvertently controlled for in the design of this cohort.

In conclusion, we found that working >40 h per week and moving or lifting a heavy load >15 times per day (including repositioning or transferring patients) were associated with reduced fecundity in a cohort of female nurses planning pregnancy. The association of heavy moving and lifting and reduced fecundity was even more pronounced among overweight or obese women. The potential bias due to an infertile worker effect and residual confounding due to factors related to employment status, male characteristics and sexual activity need to be considered when interpreting these results. We were unable to discern whether the effects of working long hours or moving or lifting heavy loads may be reversible once exposure ends. Future research in other occupations is needed to further evaluate the effect of heavy work, both in terms of physical strain and long hours, on fertility.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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What this paper adds

- Occupational factors have been related to several reproductive health outcomes; however, there are conflicting data on the association between work schedule and physical factors in relation to fecundity.
- In a large cohort of female nurses planning pregnancy, women working greater than 40 h per week and who had a greater frequency of lifting or moving heavy loads had reduced fecundity.
- Given the high prevalence of these exposures, future research in other occupations is needed to further evaluate the effect of heavy work, both in terms of physical strain and long hours, on fertility.

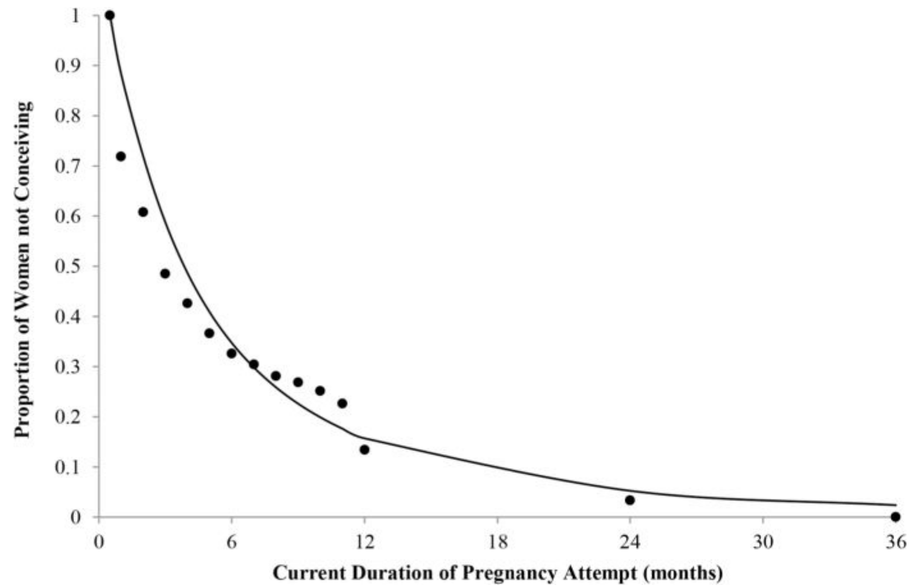

Figure 1.

Log-normal survival function of the duration of ongoing pregnancy attempt (solid line) and actual distribution of ongoing pregnancy attempt (black dots) among women in the Nurses' Health Study 3 cohort (n=1739).

Table 1

Baseline demographic characteristics of women with information on work schedule and time to pregnancy in the Nurses' Health Study 3 cohort (n=1739)

Demographic characteristics	N (%)
Age at study entry (years)	
<30	318 (18.3%)
30–37	1017 (58.5%)
>37	404 (23.2%)
Body mass index (kg/m^2)	
Underweight (<18.5)	31 (1.8%)
Normal weight (18.5–24.9)	941 (54.1%)
Overweight (25–29.9)	378 (21.7%)
Obese (>30)	389 (22.4%)
Smoking status*	
Never	1349 (77.6%)
Former	309 (17.8%)
Current	80 (4.6%)
Typical hours of sleep†	
≤5	80 (5.8)
6	290 (20.9)
7–9	1002 (72.3)
≥10	14 (1.0)
Marital status	
Never married	294 (16.9%)
Married	1317 (75.9%)
Divorced/separated/widowed	74 (4.3%)
Domestic partnership	51 (2.9%)
Race	
White	1583 (92.8%)
Black	37 (2.2%)
Asian	44 (2.6%)
American Indian	2 (0.1%)
Hawaiian or Pacific Islander	4 (0.2%)
Mixed race	36 (2.1%)
Hispanic ethnicity	72 (4.1%)
Pregnancy history	
0 pregnancies	1034 (59.5%)
1 pregnancy	404 (23.2%)
2 pregnancies	173 (10.0%)
3+ pregnancies	128 (7.4%)
Menstrual cycle regularity†	
Regular menses	973 (79.3%)

Demographic characteristics	N (%)
Irregular menses	254 (20.7%)
Menstrual cycle length (days)[†]	
≤25	130 (10.9)
26–31	1043 (87.2)
32–50	20 (1.7)
>50	3 (0.3)

Data are presented as N (%) unless otherwise noted.

[*] Two women are missing information on smoking status.

[†] Sleep and menstrual cycle characteristics were assessed during follow-up so not all women were eligible to have answered these questions yet.

Table 2

Association between work schedule and duration of ongoing pregnancy attempt in Nurses' Health Study 3 women (n=1739)

	N (%)	Median duration in months (25th, 75th percentile)	Model 1 time ratio (95% CI)	Model 2 time ratio (95% CI)	Model 3 time ratio (95% CI)
Typical work schedule over past year					
Days only	1006 (58.0)	3.5 (1, 12)	1.0 (REF)	1.0 (REF)	1.0 (REF)
Evenings only	87 (5.0)	3.0 (1, 8)	1.05 (0.82 to 1.33)	1.07 (0.84 to 1.35)	1.06 (0.84 to 1.35)
Nights only	298 (17.2)	3.0 (1, 8)	1.01 (0.87 to 1.16)	1.01 (0.87 to 1.16)	0.94 (0.81 to 1.08)
Rotating with nights	273 (15.7)	3.0 (1, 8)	0.90 (0.78 to 1.04)	0.93 (0.80 to 1.07)	0.88 (0.76 to 1.02)
Rotating no nights	71 (4.1)	3.0 (1, 9)	0.86 (0.67 to 1.12)	0.89 (0.69 to 1.15)	0.87 (0.67 to 1.12)
Weekly hours of nursing work over past year (h/week)					
1–20	128 (7.4)	3.0 (1, 9.5)	0.94 (0.77 to 1.15)	0.93 (0.77 to 1.13)	0.98 (0.80 to 1.19)
21–40	1144 (65.8)	3.0 (1, 8)	1.0 (REF)	1.0 (REF)	1.0 (REF)
>40	467 (26.9)	5.0 (2, 12)	1.24 (1.10 to 1.40)	1.21 (1.08 to 1.36)	1.20 (1.07 to 1.35)
P-trend			0.0004	0.001	0.005
Frequency of night work in past month (night shifts/week)					
None	1170 (67.6)	3.0 (1, 11)	1.0 (REF)	1.0 (REF)	1.0 (REF)
≤1	207 (12.0)	3.0 (1, 11)	1.06 (0.90 to 1.24)	1.08 (0.92 to 1.26)	1.02 (0.87 to 1.20)
2–3	266 (15.4)	3.0 (1, 7)	0.95 (0.82 to 1.10)	0.97 (0.84 to 1.12)	0.92 (0.79 to 1.07)
>3	89 (5.1)	4.0 (1, 10)	1.10 (0.87 to 1.39)	1.11 (0.88 to 1.40)	1.01 (0.80 to 1.27)
P-trend			0.93	0.78	0.47
Duration of rotating night shifts (year)					
Never	910 (52.5)	3.0 (1, 10)	1.0 (REF)	1.0 (REF)	1.0 (REF)
<1	417 (24.0)	3.0 (1, 10)	1.02 (0.90 to 1.16)	1.02 (0.91 to 1.16)	1.03 (0.91 to 1.17)
1–2	246 (14.2)	3.0 (1, 12)	1.06 (0.91 to 1.23)	1.05 (0.90 to 1.22)	1.03 (0.88 to 1.20)
≥3	161 (9.3)	4.0 (2, 12)	1.06 (0.88 to 1.28)	1.09 (0.91 to 1.30)	1.04 (0.86 to 1.25)
P-trend			0.43	0.34	0.66
Duration of permanent night shifts (years)					
Never	757 (43.6)	3.0 (1, 10)	1.0 (REF)	1.0 (REF)	1.0 (REF)
<1	491 (28.3)	3.0 (1, 10)	1.05 (0.93 to 1.19)	1.03 (0.91 to 1.16)	1.03 (0.91 to 1.17)
1–2	285 (16.4)	4.0 (1, 11)	1.11 (0.95 to 1.28)	1.09 (0.94 to 1.26)	1.09 (0.94 to 1.26)
≥3	205 (11.8)	4.0 (1, 12)	1.00 (0.84 to 1.18)	0.97 (0.82 to 1.15)	0.95 (0.80 to 1.12)

	N (%)	Median duration in months (25th, 75th percentile)	Model 1 time ratio (95% CI)	Model 2 time ratio (95% CI)	Model 3 time ratio (95% CI)
P-trend			0.86	0.88	0.66
Duration of night shifts (years)					
Never	436 (25.1)	3.0 (1, 10.5)	1.0 (REF)	1.0 (REF)	1.0 (REF)
<1	401 (23.1)	3.0 (1, 8)	0.93 (0.80 to 1.08)	0.94 (0.81 to 1.08)	0.95 (0.82 to 1.10)
1–1.9	388 (22.4)	3.0 (1, 8)	0.97 (0.84 to 1.13)	0.96 (0.83 to 1.11)	0.96 (0.83 to 1.12)
2–4	270 (15.6)	3.0 (1, 11)	1.00 (0.85 to 1.18)	0.99 (0.84 to 1.16)	0.97 (0.82 to 1.15)
>4	239 (13.8)	5.0 (2, 12)	1.11 (0.93 to 1.32)	1.10 (0.92 to 1.30)	1.05 (0.88 to 1.26)
P-trend			0.13	0.19	0.39

Accelerated failure time models were used to estimate the time ratios and 95% CIs. Tests for linear trend use the median values in each category as a continuous variable.

Model 1 is adjusted for age.

Model 2 is adjusted for age, race, BMI, smoking status and marital status.

Model 3 is adjusted for variables in Model 2 and current night work, weekly hours of nursing work, frequency of moving or lifting a heavy load, duration of night work, and current exposure to radiation, antineoplastic drugs, high-level disinfectants, and anaesthesia gas.

BMI, body mass index.

Table 3

Association between physical labour at work in the past month and duration of ongoing pregnancy attempt in Nurses' Health Study 3 women (n=1739)

	N (%)	Median duration in months (25th, 75th percentile)	Model 1 time ratio (95% CI)	Model 2 time ratio (95% CI)	Model 3 time ratio (95% CI)
Duration of standing/walking (h/day)					
0 or less than 1	114 (6.6)	4.0 (1, 12)	1.07 (0.86 to 1.33)	1.05 (0.85 to 1.30)	1.19 (0.95 to 1.49)
1–4	438 (25.3)	4.0 (1, 11)	0.94 (0.82 to 1.08)	0.94 (0.82 to 1.07)	0.99 (0.86 to 1.14)
5–8	583 (33.7)	3.0 (1, 10)	1.0 (REF)	1.0 (REF)	1.0 (REF)
>8	595 (34.4)	3.0 (1, 10)	1.01 (0.90 to 1.15)	1.02 (0.90 to 1.15)	0.98 (0.86 to 1.11)
P-trend			0.60	0.46	0.39
Frequency of moving or lifting a heavy load (25+ lbs) (times/day)					
None	536 (30.9)	3.0 (1, 9)	1.0 (REF)	1.0 (REF)	1.0 (REF)
1–5	696 (40.2)	3.0 (1, 11)	1.13 (1.00 to 1.28)	1.12 (1.00 to 1.27)	1.13 (1.00 to 1.28)
6–15	383 (22.1)	3.0 (1, 9)	1.16 (1.00 to 1.33)	1.14 (0.99 to 1.32)	1.15 (0.99 to 1.33)
>15	117 (6.8)	5.0 (2, 12)	1.56 (1.25 to 1.94)	1.50 (1.21 to 1.85)	1.49 (1.20 to 1.85)
P-trend			0.0005	0.001	0.002

Accelerated failure time models were used to estimate the time ratios and 95% CIs. Tests for linear trend use the median values in each category as a continuous variable.

Model 1 is adjusted for age.

Model 2 is adjusted for age, race, BMI, smoking status and marital status.

Model 3 is adjusted for variables in Model 2 and current night work, weekly hours of nursing work, duration of night work, and current exposure to radiation, antineoplastic drugs, high-level disinfectants, and anaesthesia gas. Model 3 for duration of standing/walking was also further adjusted for frequency of moving or lifting a heavy load.

BMI, body mass index.